THE RECENT APPEARANCE OF *NOTOSPISULA TRIGONELLA* (LAMARCK) (MOLLUSCA; BIVALVIA; MACTRIDAE) IN THE SWAN ESTUARY

By B. R. WILSON* and
G. W. KENDRICK*

Plate 2.

A small bivalve, *Notospisula trigonella* (Lamarck, 1818), is at present extremely abundant in the Swan Estuary, Western Australia. Yet, in spite of considerable work on the fauna of this estuary in the last decade, or so, there is no positive record of its presence prior to 1964. Specimens have also been collected recently at other localities in Western Australia although the original description of the species from Shark Bay by Lamarck in 1818 is the only previous record of it in the state.

The fauna of the Swan Estuary is impoverished. Only a few species are able to persist within the estuary throughout the year because there are unusually severe seasonal changes in salinity (Serventy, 1955; Spencer, 1956; Wilson, 1964). During summer there is discharge of river water into the estuary which is filled with saline water carried in by weak tidal forces from the sea. In summer many marine organisms enter with the sea water and temporarily establish themselves. Most of these fail to survive the winters which are characterised in most years by a long period of flood conditions including almost complete scour of the estuary by fresh water.

Today *N. trigonella* is abundant throughout the lower estuary on the shallow sand cays and banks. The animals burrow in the sand with their long siphons extended through the water-sand interface. In places they are so abundant that they prickle the feet of persons wading in the water. They also occur in the mud in deeper channels. At the end of each winter recently-dead specimens are cast ashore in quantity indicating that the shallow populations are heavily depleted by the effect of the winter floods. However, some survive, or perhaps the shallows are repopulated from more saline water deeper down or further downstream.

Recent records: *N. trigonella* was first observed in the Swan Estuary in December 1964 when several live adult specimens were dredged at Canning Bridge by Mr and Mrs R. Slack-Smith of the Western Australian Fisheries Department. There is no information on how abundant or widespread they were at that time.

In September 1965, after the winter floods, vast numbers of empty but paired valves of this species were present along the beaches of Matilda Bay (Crawley) and the Nedlands foreshore. Lesser numbers were then present downstream at Minim Cove, North Fremantle and upstream at Belmont. Presumably a large population of the animals which had flourished during the previous summer, had been heavily depleted by

---

* Western Australian Museum, Beaufort St., Perth, W.A.

the winter floods of mid-1965. However, in mid-February 1966, a dense living population of the species was again present in shallow water on the sandy sills around the shores of Matilda Bay.

There are no records of *Notospisula* living in the Swan Estuary before 1964. Thiele (1930) did not list any mactrid when reporting the results of the 1905 Hamburg South-West Australian Expedition which had several collecting stations in the estuary. The genus is not listed in brief accounts of the fauna of the estuary by Serventy (1955) and Kendrick (1960). Between the years 1956 and 1963 the Marine Group of the W.A. Naturalists' Club made many excursions collecting invertebrates, particularly molluscs, in the Swan Estuary, yet made no record of *Notospisula* (Wilson and Kendrick, unpublished data). Nor was the species noticed during a study of the biology of a mussel in the Swan Estuary in the years 1960 to 1963 (Wilson, 1964).

At Careening Bay, Garden Island, five living specimens were collected on a shallow sandy sill in December 1965. The sand flats at the southern end of Careening Bay have been intensively but irregularly collected by the authors and associates since 1956. In February and March 1963, students of the Department of Zoology, University of Western Australia, conducted a detailed survey of the fauna of these flats (Phillips, 1963) but did not record *Notospisula*.

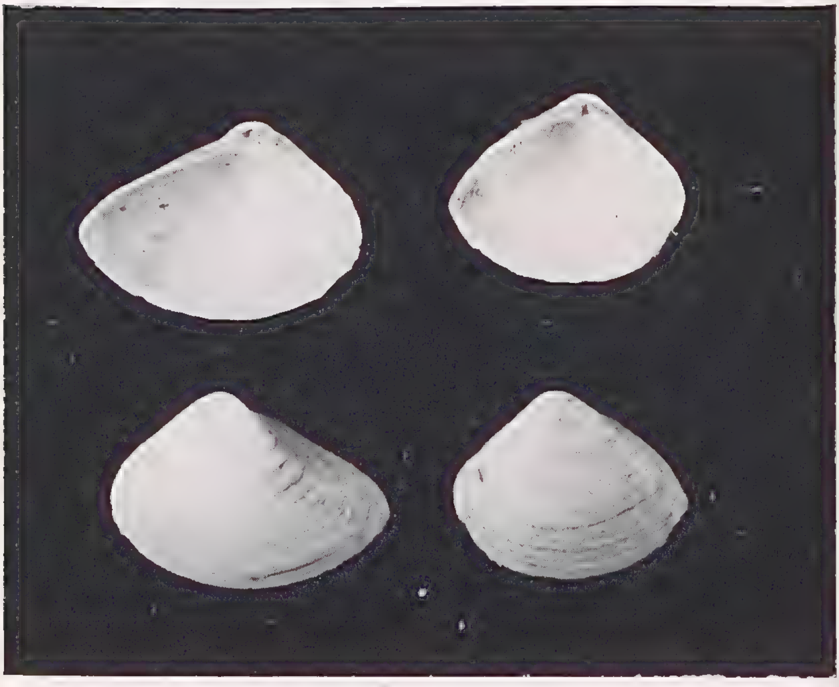

PLATE 2

Two specimens of *Notospisula trigonella* (Lamarck) collected at the new railway bridge, Fremantle, Swan Estuary, G. W. Kendrick, 10th November, 1966, W.A.M. regn numbers 581-67 and 582-67. These two specimens represent the extreme forms selected from a single sample (W.A.M. 580-67). Approx. double natural size.

Living specimens have been collected in April and December, 1965 on a sand bank just inside the mouth of Peel Inlet at Mandurah, and in January, 1967 in Nornalup Inlet on the south coast of Western Australia. These and other localities have been collected fairly thoroughly in recent years without previous record of *Notospisula*, but we are unable to certify that the species has become esablished there recently, although this seems probable.

In March 1966 we went to Shark Bay looking specifically for *Notospisula* but failed to find any there. Dr R. W. George dredged several single valves much further north off Troughton Island on 23 October 1962.

Fossil records: Extensive Quaternary shell-beds occur around the shores of the Swan Estuary. Reath (1925) listed many species of molluscs from Pleistocene faunas at Peppermint Grove and Minim Cove and from post-Pleistocene shell-beds of the lower Swan and Canning Rivers, but no mactrid was included in the list. The faunal list of the Pleistocene shell-beds was revised and extended by Kendrick (1960) but the additions included no mactrid. Nor have any been collected there during a more detailed study of the deposits since 1960. Intensive collecting of unconsolidated shell-beds of post-Pleistocene age, carried out by one of us since 1950, failed to produce any mactrid until recently.

It was not until September 1964 that *Notospisula* was first recorded from Quaternary shell-beds of the region. At that time Mrs Slack-Smith collected a small sample of shells from dumped material being used to reclaim part of the Swan Estuary near the Narrows Bridge. The sample included three pairs of articulated valves and one single valve.

In December 1965 single valves were found on a bank of dredged shelly material at the Victoria Park end of the Causeway. This particular dredging was begun in December, 1964.

Further records of *Notospisula* shells were made in March 1966 from re-worked post-Pleistocene shell-sand on the reclaimed foreshore at Attadale. This reclamation was carried out between October 1963 and October 1964 (personal communication Mr. C. C. Jameson, Western Australian Department of Public Works).

Thus it can be stated that the only occurrences of *Notospisula* known to us from Quaternary shell-beds of the Swan Estuary, come from material which was dredged less than a year before the initial discovery of living shells at Canning Bridge in December 1964. The specimens from all three sites have an intact epidermis, lack the chalky texture of the fossil shells, and have the appearance of recently-dead shells. While they could be fossils of the same age as the many shells with which they occur, it is more probable that they are of very recent origin, and were introduced into the shell-beds by the dredging operations.

TAXONOMY OF *NOTOSPISULA*

The generic name *Notospisula* was introduced by Iredale (1930) without description or explanation. *Gnathodon parva* Petit, 1853 was nominated as the type species, but Iredale also included in the new genus *Mactra trigonella* Lamarck, 1818, and *Spisula cretacea* Angas, 1867.

Because no reasons were advanced for the introduction of the new name, the status of *Notospisula* remains in doubt, but it must be accepted until a generic revision of the Mactridae is attempted.

Hedley (1901) recognized only one species of this group in eastern Australia, for which he used the name *Spisula parva* (Petit, 1853). He included as synonyms *Mactra rostrata* Reeve, 1854, *Mactra corbuloides* Deshayes, 1854, *Spisula cretacea* Angas, 1867, *Spisula producta* Angas, 1867, and *Mactra fluviatilis* Angas, 1871. Hedley remarked on the variability of this bivalve in size and shape.

Lamy (1914) reported on the four syntypes of *Mactra trigonella* Lamarck, 1818 which he stated were collected by Peron at Shark Bay, Western Australia. Iredale 1930 gave King George Sound as the type locality without explanation and Cotton (1961) followed suit. While Iredale may have had reasons for this change, without knowing what they were we prefer to accept the locality given by Lamarck and Lamy.

Lamy considered the type specimens identical with *Gnathodon parvum* Petit. Petit's types are probably also in the Paris Museum and it is presumed that Lamy compared them with Lamarck's specimens, although he did not say so.

Hedley (1916) followed Lamy and synonymized *parvum* Petit with *trigonella* Lamarck which has priority. Iredale (1930) rejected this conclusion, basing his opinions solely on the difference in locality and his ambiguous reference to "geographic variation". Iredale also considered *parvum* and *cretacea* distinct species, but again his reasons were not explained except for the statement that they are "easily separated".

We have examined the series of *Notospisula* in the Australian Museum which, presumably, includes the specimens examined by Hedley and Iredale, and we can recognize only one species. As Hedley (1901) remarked, the species is variable in shape. It is true that one can "easily separate" the extreme variants but most of the series is intermediate preventing the conclusion that the extreme forms represent distinct species.

For these reasons we find no support for Iredale's contention that *trigonella* Lamarck, *parvum* Petit and *cretacea* Angas are distinct species and we propose to follow Lamy and Hedley and unite them under the prior name *Notospisula trigonella* (Lamarck, 1818).

SYNONYMY

Notospisula trigonella (Lamarck, 1818)

Mactra trigonella Lamarck, 1818, *Anim. sans. vert.* 5: 479. (La baie des chiens marins [Shark Bay].) Four syntypes in Mus. National D'Hist. Nat., Paris, coll. by Peron, see Lamy, 1914, p. 245.

Gnathodon parvum Petit, 1853, *J. Conch., Paris,* 4: 358, pl. 13, figs 9-10 (Moreton Bay, Qld). Types in Mus. National D'Hist. Nat., Paris. ?

Mactra rostrata Reeve, 1854, *Conch. Icon.,* 8: pl. 19, fig. 104. (Moreton Bay, Qld). *non* Spengler, 1802; Philippi, 1846.

Mactra corbuloides Deshayes, 1854, *Proc. Zool. Soc. London,* p. 63 (Hab. ? , Mus. Cuming).

Spisula cretacea Angas, 1867. *Proc. Zool. Soc. London*, p. 909, pl. 44, fig. 6 (dredged at Port Stephens, off Tarlee (sic) [N.S.W.]).

Spisula producta Angas, 1867, *Proc. Zool. Soc. London*, p. 909, pl. 44, fig. 7 (Johnson's Bay and Parramatta River, Port Jackson [N.S.W.]).

Mactra fluviatilis Angas, 1871, *Proc. Zool. Soc. London*, p. 20, pl. 1, fig. 31 (dredged in brackish water, in 2 fathoms Hawkesbury River, New South Wales).

DISTRIBUTION

Today *N. trigonella* occurs around the whole coast of Australia. It tolerates a wide variety of habitats, occurring at moderate depths (50 fathoms) in the open sea and in the shallows of sheltered bays and estuaries. It is able to flourish in brackish conditions.

Petit, Reeve and Angas each recorded *Notospisula trigonella* (under other names) from various eastern Australian localities during the mid-19th century and the Australian Museum material consists of specimens collected in the region at irregular intervals since then. There can be no doubt that the species has been well established in eastern and south-eastern Australia for a long time. On the other hand, we know of no confirmed record of the species in south-western Australia, apart from Lamarck's original description, until 1964.

Most of the following locality records are based on the specimens in the Australian Museum and the Western Australian Museum. Others have been taken from Cotton (1961) and Macpherson and Gabriel (1962).

LOCALITY RECORDS

Queensland: (Specimens in Aust. Mus.): 4 to 14 fm., Albany Passage, Torres Straits; Van Diemen Inlet; Green Island; Barny Point; Port Curtis; off Horsey River; Cardwell; Karumba; Caloundra; Stradbroke Island; Cribb Island sands, Moreton Bay.

New South Wales: (Specimens in Aust. Mus.): Lake Illawarra; Parramatta River; Lake Macquarie, Wyong Lake; Hawkesbury River; Sydney Harbour; Botany Bay; Dee Why Lagoon; Lake Malacoota (Vic.); Patonga.

Tasmania: (Specimens in Aust. Mus.): Tamar River.

Victoria: (see Macpherson & Gabriel 1962): Port Melbourne; South Melbourne; St. Kilda; Western Port.

South Australia: (see Cotton, 1961): Gulf St. Vincent; Encounter Bay; Beachport; Kingston; Glenelg River; Corney Point.

Western Australia: (Specimens in W. Aust. Mus.): 50 fm. 130 m. E.N.E. Troughton Island; 50 fm. 150 m. E.N.E. Troughton Island; various localities in Swan Estuary; intertidal flats, Careening Bay, Garden I.; Peel Inlet, Mandurah; sandy shallows, Nornalup Inlet, G. W. Kendrick, Jan. 1967.

Also Shark Bay (type loc.).

DISCUSSION

We conclude that *N. trigonella* first appeared in the vicinity of Fremantle in 1964 or perhaps in 1963. Since then it has flourished in the Swan Estuary where it is able to persist throughout the year. Small populations also occur in the Peel Inlet at Mandurah and in sheltered Careening Bay at Garden Island, and we believe that the occurrence of the species at these localities is the result of the same recent introduction. We are less certain about the population in Nornalup Inlet because collecting along the south coast has been less thorough, but it seems likely that it too is of recent origin.

The specimens collected in 1962 off Troughton Island in the far north of Western Australia may represent a permanent continuation of the species' range from North Queensland.

The sudden appearance of *N. trigonella* in south Western Australia, and more particularly in the Swan Estuary, is an event of some significance and poses two major questions:

(i) Was their introduction and subsequent success merely the result of a unique, fortuitous event enabling larvae to establish themselves in a place which has always been suitable for them, but which they have not reached before?

(ii) Has the local environment changed so that pelagic larvae reaching the area occasionally were at last able to settle and flourish whereas previously it was unfavourable to them and they perished?

Accepting that there is only one species of *Notospisula* in Australia, the introduction could have been from northern populations or from the south-east. Environmental temperature change is unlikely to be involved because the species occurs through such a wide temperature range in other places. It seems most likely that an unusual or unique set of ocean currents, corresponding with the breeding season of a northern or a south-eastern population, carried larvae to the Fremantle area for the first time. However, great distances are involved.

The nearest northern locality recorded for *N. trigonella* is Shark Bay, about 500 miles north of the Swan Estuary, and no specimens have been collected there since the beginning of the 19th century. The nearest northern locality from which the species has been recorded since then is Troughton Island, well over two thousand miles away.

A source population may have been present but overlooked on the south coast of Western Australia (e.g. at Nornalup Inlet) in which case larvae must have been carried north around Cape Leeuwin. However, if the Nornalup Inlet population is of recent origin contemporaneous with the introduction into the Swan Estuary, then the source population was probably in South Australia. In either case extension of the species range northwards to the Swan Estuary would represent a significant achievement, since it would involve a journey for the larvae against the major water currents.

Whatever its origin, the sudden appearance of *N. trigonella* in the Swan Estuary and nearby localities is a striking example of change in a species' distribution.

One effect is already evident. Vast numbers of dead shells have been deposited within the upper substrate and on the beaches of the estuary which in many places were originally largely composed of fossil shell-beds. Soon it will be difficult to distinguish these recently-dead shells from the genuine fossils in the shell-beds. Such an event as this, if unrecorded, could adversely influence future interpretations of fossil faunas and stratigraphy of the important Pleistocene and post-Pleistocene sediments in the area.

ACKNOWLEDGMENTS

We are grateful to Mr Richard Slack-Smith and Mrs. Slack-Smith who collected the first specimens of *Notospisula* in the Swan Estuary and to Mrs Hope Black who identified those specimens. Dr D. F. McMichael kindly loaned us specimens in the collection of the Australian Museum. Dr J. McIntyre provided data on the species in estuaries of New South Wales. Dr R. W. George read the manuscript.

LITERATURE CITED

COTTON, BERNARD C., 1961. *South Australian Mollusca. Pelecypoda.* Govt. Printer. Adelaide. 363 pp.

HEDLEY, CHARLES, 1901. Studies on Australian Mollusca. Pt. 5. *Proc. Linn. Soc. N.S.W.*, 1901, 26, (4): 700-708, pl. 34.

HEDLEY, CHARLES, 1916. Studies on Australian Mollusca. Pt. 13. *Proc. Linn. Soc. N.S.W.*, 41 (4):681-719, pls. 46-52.

IREDALE, TOM, 1930. More notes on the marine mollusca of New South Wales. *Rec. Aust. Mus.*, 17 (9):384-407, pls. 62-65.

KENDRICK, GEORGE W., 1960. The fossil mollusca of the Peppermint Grove Limestone, Swan River District of Western Australia. *West. Aust. Nat.*, 7 (3):53-66.

LAMY, ED., 1914. Notes sur les espèces du genre *Mactra* décrites par Lamarck. *Bull. Mus. Hist. Nat. Paris,* 1914, no. 4:239-247.

MACPHERSON, J. HOPE AND C. J. GABRIEL, 1962. *Marine Molluscs of Victoria.* Melbourne University Press. 475 pp.

PHILLIPS, BRUCE F., 1963. *The fauna on a sandy shore at Careening Bay, Garden Island.* Unpublished thesis [in] library of University of Western Australia.

REATH, J. L., 1925. The mollusca from the sub-recent shell beds of the lower Swan River. *J. Proc. R. Soc. West. Aust.* 11:31-41.

SERVENTY, D. L., 1954. The fauna of the Swan River Estuary. Chapter 10, pp. 70-77, in *Swan River Reference Committee, report on Pollution of Swan River.* Govt. Printer, Perth.

SPENCER, R. S., 1956. Studies in Australian estuarine hydrology. II. The Swan River. *Aust. J. Mar. Freshw. Res.* 7:193-253.

THIELE, J., 1930. Gastropoda und Bivalvia. In: Michaelsen, W. and Hartmeyer, R. *Die Fauna Südwest-Australiens* 5:559-596.

WILSON, BARRY R., 1964. *Breeding biology of some Western Australian marine and estuarine Mytilidae (Mollusca: Bivalvia).* Unpublished thesis [in] library of University of Western Australia.